NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

THE IMPLEMENTATION OF A COMPUTER SCHEDULING SYSTEM WITHIN NAVAL SHIPYARDS

by

Kennis L. Sigmon

September 1985

Thesis Advisor: Michael Spencer

Approved for public release; distribution is unlimited

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) The Implementation of a Computer Scheduling System Within Naval Shipyards		5. TYPE OF REPORT & PERIOD COVERED Master's Thesis September 1985
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Kennis L. Sigmon		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Postgraduate School Monterey, CA 93943-5100		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Postgraduate School Monterey, CA 93943-5100		12. REPORT DATE September 1985
		13. NUMBER OF PAGES 61
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution is unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

scheduling systems, shipyard scheduling, system implementation, system networking

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

In this research, the author addresses the challenge of implementing a Fundamental Automated Scheduling System into the Naval Shipyards. The problem considered is that of how to most effectively integrate a new computerized system into the existing shipyard arrangement. The author first profiles the mission, organization, duties and constraints of a Naval shipyard, then develops the background information concerning the (Continued)

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

S N 0102-LF-014-6601

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

ABSTRACT (Continued)

requirements and system description of the new scheduling system. The discussion then shifts to a description of the implementation plans developed by three Naval shipyards and the required management considerations. The research concludes with a summary of recommended implementation approaches and suggestions for further research.

The Implementation of a Computer Scheduling System Within Naval Shipyards

by

Kennis L. Sigmon
Commander, United States Navy
B.S., Old Dominion University, 1971

Submitted in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE IN INFORMATION SYSTEMS

from the

NAVAL POSTGRADUATE SCHOOL
September 1985

ABSTRACT

In this research, the author addresses the challenge of implementing a Fundamental Automated Scheduling System into the Naval shipyards. The problem considered is that of how to most effectively integrate a new computerized system into the existing shipyard arrangement. The author first profiles the mission, organization, duties and constraints of a Naval shipyard, then develops the background information concerning the requirements and system discription of the new scheduling system. The discussion then shifts to a description of the implementation plans developed by three Naval shipyards and the required management considerations. The research concludes with a summary of recommended implementation approachs and suggestions for further research.

TABLE OF CONTENTS

I. INTRODUCTION

A. PURPOSE 10

B. SCOPE 11

C. RESEARCH TECHNIQUE 11

II. THE NAVAL SHIPYARD, IT'S ORGANIZATION, DUTIES, AND CONSTRAINTS

A. GENERAL OVERVIEW 13

B. ORGANIZATION 14

C. MAJOR OVERHAUL SEQUENCE 16

D. THE OVERHAUL ASSIGNMENT PROCESS 19

E. SHIPYARD MANAGEMENT CONSTRAINTS 19

F. SCHEDULE ADHERANCE 21

III. BACKGROUND, DESCRIPTION AND UTILIZATION CONCEPTS OF FASS

A. WHY DO WE NEED FASS? 22

B. SYSTEM DESCRIPTION 26

C. INITIAL UTILIZATION CONCEPTS 31

IV. IMPLEMENTATION PLANNING CONSIDERATIONS

A. INCORPORATING FASS INTO EXISTING SHIPYARD MIS 34

B. ESTABLISHED PLANS TO IMPLEMENT FASS WITHIN NAVAL SHIPYARDS 36

1. Philadelphia 37

2. Long Beach 41

3. Puget Sound 42

C. OVERALL MANAGEMENT CONSIDERATIONS FOR USE OF FASS

1. Top management support 45

2. Training and System Acceptance 47

3. Post Review Program 49

V. CONCLUSIONS

A. FASS USEFULLNESS 51

B. SYSTEM NETWORKING 51

C. SYSTEM ACCEPTANCE 52

D. GROWTH 52

VI. RECOMMENDATIONS

A. DATA ENTRY AND STORAGE 53

B. FASS CONTROL 55

C. SUPERVISOR USER GROUP 55

D. IN HOUSE REVIEW 56

E. NAVSEA REVIEW 56

VII. FURTHER RESEARCH OPTIONS 57

LIST OF REFERENCES 58

BIBLIOGRAPHY 60

INITIAL DISTRIBUTION LIST 61

LIST OF TABLES

I. SUMMARY OF IMPLEMENTATION CRITERION 54

LIST OF FIGURES

1. Partial Production Department Organization Chart 15

2. Typical Overhaul Sequence of Events 18

3. Standard Hardware/Software Package 28

4. FASS Process 29

5. Typical Hardware Layout 32

6. Shipyard MIS Organization 36

7. Shipyard Networks 40

ACKNOWLEDGEMENTS

The author gratefully acknowledges the educational experience and assistance provided by the following personnel in the preparation of this research: Mr. Dan Zuber, Mr. Mike Jones of Philadelphia Naval Shipyard; Mr. Jerry Hansen of Puget Sound Naval Shipyard; and Mr. Jim Anast, of Long Beach Naval Shipyard.

I. INTRODUCTION

A. PURPOSE

The current environment of Naval shipyards is characterized by an decreasing workload and large reductions budget. This situation has called for increased and uniform management control. The sensitivity of management and schedule control over overhaul duration and cost has forced the conversion from the installed PERT/CPM scheduling system to a Fundamental Automated Scheduling System [FASS] which will support real time network analysis and decision making. This real time scheduling system is aimed at allowing the shipyards to better manage manhours and material cost which are the critical factors associated with cost overruns and meeting overhaul completion dates. With cost and time as key variables the decision was announced on 11 July 1984 that competive procurement was underway for Naval Shipyards to procure an "off-the-shelf" system in lieu of an outside "design and build" contract.[Ref.1] The focus of this research is to examine the current naval shipyard scheduling system, scheduling information flow, and organization, and then to determine the optimum strategy for implementing the new

scheduling system within the boundaries of the existing management information system.

B. SCOPE

This research addresses the main question of how the Philadelphia Naval Shipyard can best implement FASS. Due to the uniformity of the shipyards, the recommendations and conclusions are applicable to all units. In this light, numerous overhauling activities were consulted to benefit from the existing planning conducted to date by each activity. Implementation questions were not limited to physical/hardware requirements, but also encompassed areas such as management acceptance, maximum utilization of existing systems, graphics utilization and worker acceptance. For the reader to better understand the overall scernario, a section is devoted to the background and profile of the Philadelphia Naval Shipyard.

C. RESEARCH TECHNIQUE

The main bulk of this research effort were the author's interviews with key shipyard personnel. To assure accuracy of interviews, written and verbal feedback was presented to the respective personnel for comments and clarification. The author initially spent a week at the Philadelphia Naval Shipyard, two days at Puget Sound and three days at the Long Beach shipyard to understand the

basics of the Production Control Branch and FASS. Background reading was conducted to better understand the shipyard scenario as well as a look at commercial and industrial approaches to implementing a computerized scheduling system. The background readings consisted of shipyard organization manuals, shipyard MIS manuals, system requirements and specifications for FASS and historical information concerning the conception of the system procurement.

II. PROFILE OF A NAVAL SHIPYARD

A. GENERAL OVERVIEW

To help the reader understand the complexity of a Naval Shipyard, this chapter is devoted to brief look at the general duties, organization and functions of the shipyard.

The Naval Shipyard complex consists of eight member yards located in Philadelphia, Portsmouth, N.H., Pearl Harbor, Long Beach, Norfolk, Charleston, Bremerton, Washington (Puget Sound), and Mare Island. The official mission assigned to the Naval Shipyard by the Secretary of the Navy is: "To provide logistics support for assigned ships and service craft; to perform authorized work in connection with construction, conversion, overhaul, repair, alteration, dry-docking, and outfitting of ships and craft, as assigned; to perform manufacturing, research, development and test work, as assigned; to provide services and material to other activities and units, as directed by competent authority". [Ref.2]

In order to carry out their functions, each shipyard maintains an industrial plant with extensive shop facilities: shipfitting, welding, sheetmetal, pipe, inside and outside machine, paint, service and tool, electrical and electronics, and rigging. Each shipyard

also maintains a full range of engineering, design and shop personnel skills.

With the execption of nuclear work, shipyards perform basically the same function. The Philadelphia Naval Shipyard will be used throughout this text as an example.

B. ORGANIZATION

Pictured in Figure 1 is the non-nuclear organization chart for the Production Department at Philadelphia.[Ref.3] The Production Officer maintains direct access to the Shipyard Commander for all areas of production. The Repair Officer reports directly to the Production Officer and deals with production priorities and resource utilization. In order to discharge these duties the Repair Officer is supported by an Assistant Repair Officer, Docking Officer and a Production Control Branch Head. To keep track of the daily status of approximately five to ten ships, the Repair Officer assigns a Ship Superintendent to each ship.

The Production Control Branch will be examined in more detail, in that this department is responsible for the implementation and control of FASS. To support the shipyard Production Officer, the Production Control Branch is responsible for:

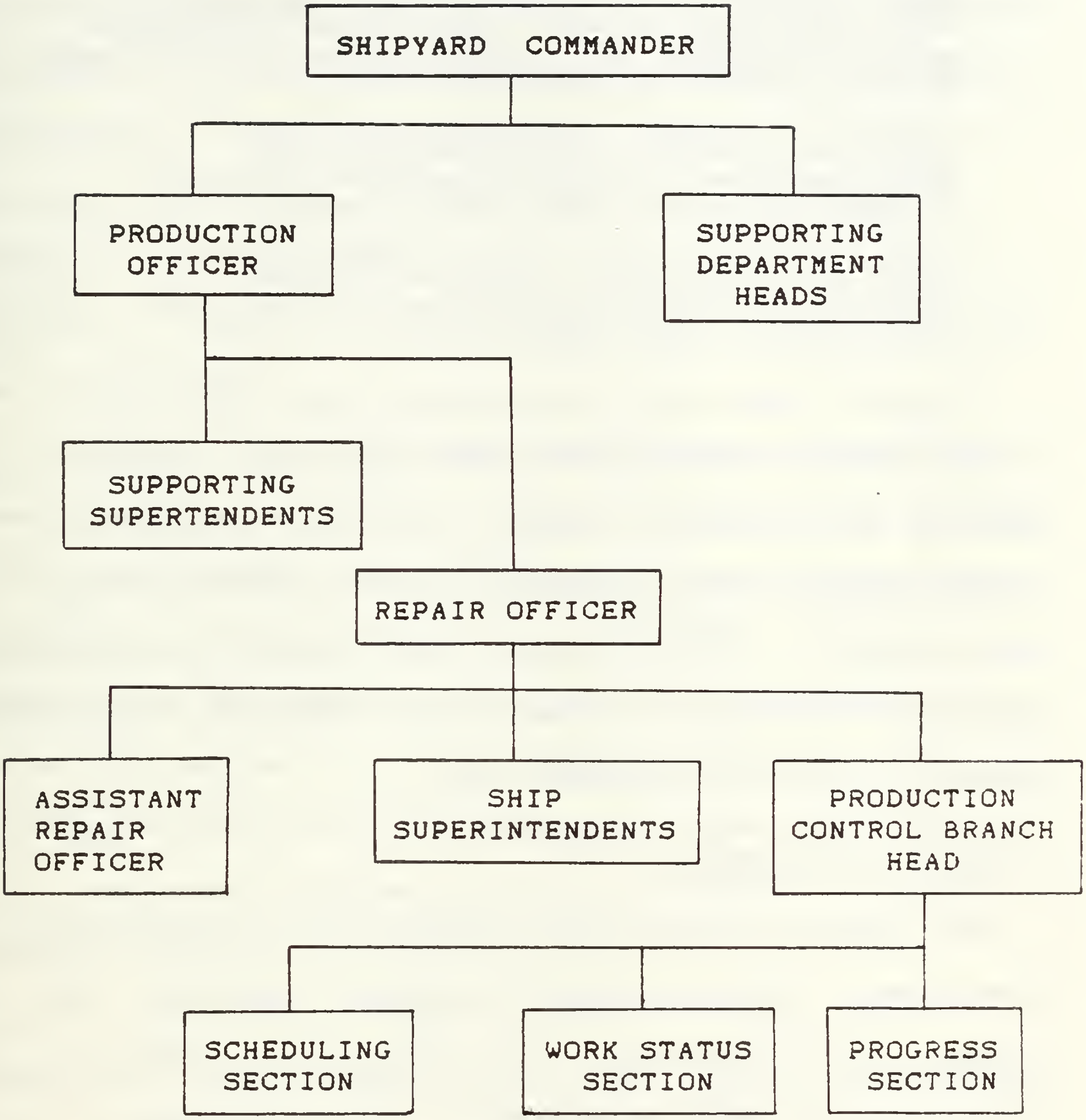


Figure 1 Partial Production Department Organization Chart

* "Providing workload, workforce, and scheduling data required in the management of the Production Department and for inter-department information and coordination.

* Serving as principal assistant to the Repair Officer on matters pertaining to work-load/workforce balance, scheduling, production material control and master work control systems for all Production Department work.

* Analyzing current, projected and long range workload and workforces and proposing changes required to achieve balance.

* Determining physical progress of productive work (including support systems and preparatory work)." [Ref. 4]

To meet these above requirements the Production Control Branch provides; PERT/CPM schedules to control and sequence the production effort; workload forecasts to manage employee resources and project future manpower requirements. The Production Control Branch also provide progress measurement to asses actual overhaul status for comparsion to the management plan.

C. OVERHAUL SEQUENCE

This section provides the reader with a background to understand a typical shipyard overhaul sequence. The easiest way to understand this process is to use the concept of EVENT MANAGEMENT. This management system is based on establishing and monitoring events. An event is defined as a specific accomplishment at a recognizable point in time. Event Hierarchy contains four

levels with appropriate management responsibility assigned at each level. Each Key Event provides a discrete, well defined point where the status of a related job may be examined and the progress evaluated. Shipyard or higher authority determine the Key Events and project milestones to determine the actual status of a ships' overhaul. A typical overhaul sequence is provided in Figure 2 with KEY EVENTS listed. The same key events depicted on Figure 2 normally establish the critical path for the overhaul.

Although the Key Events listed make the overhaul appear straightforward with only a limited number of Key Events, the reader must be exposed to the complexity of completing the work leading to a KEY EVENT. As an example, the Engineering Plant Light Off Key Event represents approximately five hundred job orders. The engineering plant of a destroyer class ship has four main engineering spaces and up to 30 smaller auxiliary spaces. Each main engineering space has 15 major systems which contain approximately 900 values and components. Each value will not only require maintenance and or rework during the yard period, but also require inspection and testing prior to and during light-off. Now add the training required by a new crew to operate a complex engineering plant with electronic

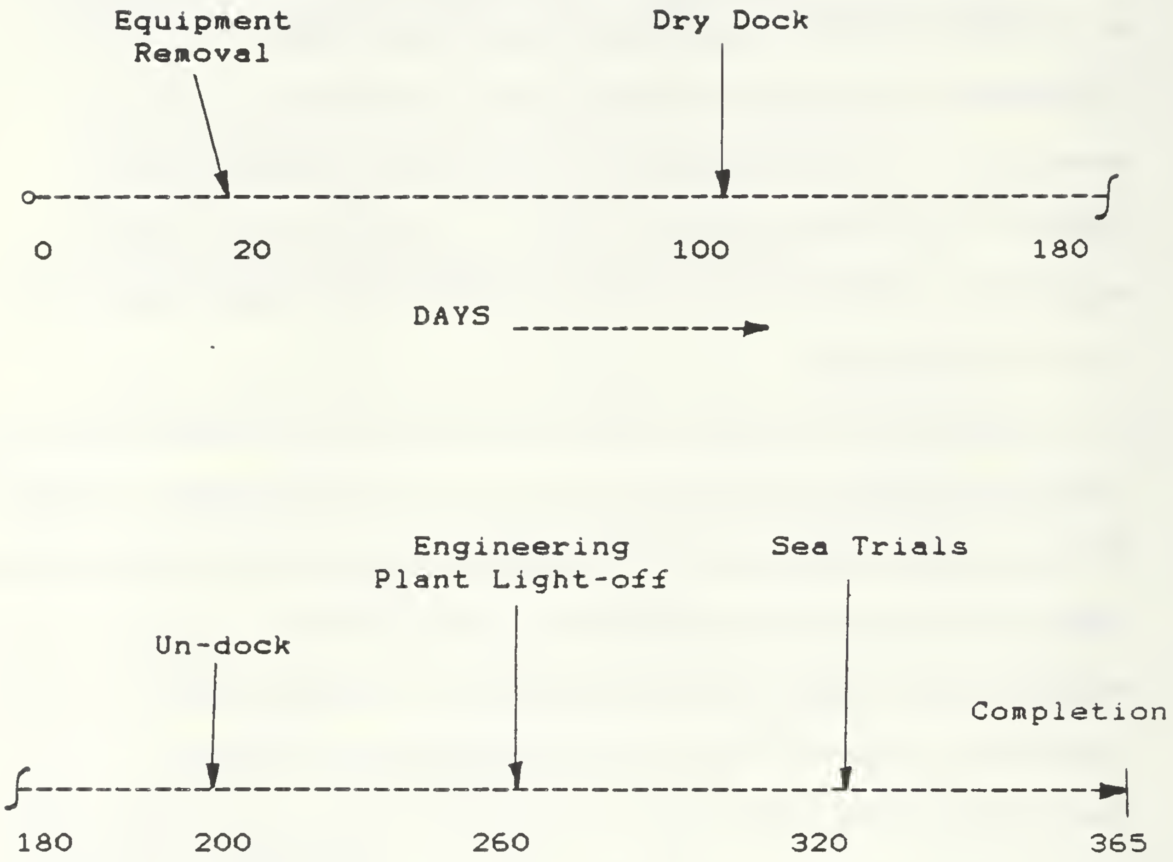


Figure 2 Typical Overhaul Sequence

systems, multiply this by four, then add the auxiliaries equivalent and the successful occurance of a Key Event becomes a mind boggling evolution of enormous size that defies the best of management techniques and systems. [Ref.5]

D. THE OVERHAUL ASSIGNMENT PROCESS

Normally a Naval shipyard does not "bid" for an overhaul contract in the same manner as a private shipyard does. Naval Sea System Commands(NAVSEA) and the Chief of Naval Operations assign workloads to individual shipyards. Such variables as construction, conversion and overhaul schedules, yard capabilities, yard specialities, existing homeport policies, and total shipwork all play a role in determining where each overhaul is assigned. The individual shipyards provide input but do not control the assignment process. This process constitutes a factor that can greatly effect a shipyard's planning process.

E. SHIPYARD MANAGMENT CONSTRAINTS

The constraints placed upon shipyard management are not radically dissimilar from industry, however, they should be briefly reviewed. The four major constraints are: available manpower, authorized work, schedule adherence and estimated cost. All four contraints are interrelated. First to be discussed is the available

manpower constraint. The shipyard must employ sufficient labor skills to complete the assigned work. To accomplish this, forecasted workloads are derived and a work force is established. Unique from the public sector shipyard is the fact that all workers are government employees which removes the option of aquiring manpower on a daily basis from a union labor pool. This constraint is often costly when shipyard workload varies significantly.

The second constraint, estimated cost, impacts directly upon the authorized work constraint. The estimated cost of work is produced by examining current man day rates, parts and material cost. Given a "fixed" dollar value that limits the cost of an overhaul, the Ship's Captain, Type Commander and the shipyard develop a priority work package of required work that fits the cost of the overhaul.

Scheduling, the third constraint, is mandated from the Chief of Naval Operations level (CNO). The CNO's office controls total force requirements and therefore limits the period of time that a fighting vessel can be taken "off the line".

The four constraints have been described briefly to enable the reader an overview of a few of the factors that dominate shipyard management. These elements combine

to severly tax the efforts of the Production and Repair Departments to develop and maintain a ships schedule.

F. SCHEDULE ADHERANCE

The bottom line of any repair activity is their ability to effect proper repairs within a limited time frame and within budget. More specifically, the shipyard Repair Officer's problem is: "How can a schedule be maintained simultaneously with several vessels in overhaul, given fixed individual unit schedules and overall fixed workload, manpower and cost constraints?" Other such factors as political and operations pressures occur, which often increase the workload, outside contracting requirements, and reduce budget and length of the overhaul. The problem is very complex and no specific algorithm can be used for a solution. This scenario often requires the shipyard management to pose "what-if" questions in juggling their resources.

III. BACKGROUND, DESCRIPTION AND UTILIZATION CONCEPTS OF FASS

A. WHY DO WE NEED FASS?

The governing body of Naval shipyards is the Naval Sea Systems Command (NAVSEA). In order to better supervise and establish standard management practices within shipyards, NAVSEA issued NAVSEAINST 4850.9 on Feburary 28 1984. [Ref. 6] This instruction was designed to establish a minimum level of operational procedures. Concerning shipyard scheduling, the instruction required each unit to develop and maintain a hierarchy of five intergrated schedules. Each decending level of scheduling would consist of more detail which must be upward compatible and supportive. The five levels of schedules must be dynamic with updates reflecting daily schedules up through the Key Event Schedule. In addition to the scheduling requirements NAVSEA work load forecasting procedures specifies data requirements to assist in the shipyard management effort. A sample of these are:

* "Develop and maintain work performance statistics by hull type (and class if appropriate) and availability type by direct labor shop.

* Base all direct labor workload projections on data provided by the Planning Department. Where a "should cost analysis report" has been prepared, modify to "will cost" by using an approved performance factor.

* During the availability, monitor actual performance and recommend revisions to the PEC as necessary in order that the "will cost" estimate represents the shipyard's best estimate of final expended direct labor mandays.

* Prepare and maintain workload forecasts for all major direct labor shops, including support shops.

* Prepare quarterly staffing recommendations for all major direct labor shops, including support shops, for use by the Management Engineering Office and other Departments in establishing departmental ceiling and staffing plans.

* Produce Workload and Resource Reports and associated reports." [Ref. 4: pp.3]

Although the above requirements were made to improve shipyard performance, the existing Automated Data Processing technology at the various shipyards could not support the requirements. Shipyard workloads are managed by the Production Control Branch, using both automated and manual techniques, including hand drawn PERT/CPM CHARTS and batch inputs to the shipyard management information system. Numerous shipyards had already begun utilizing commercial software packages to assist in network scheduling, however, most were still incapable of fulfilling the NAVSEA requirements even with these packages. As an example the shipyard MIS, in the batch mode, returned schedule information in one to three days. Manual network drawing may take from two to several weeks. With these time constraints the information provided to management was too late and of little use.

At this point in time the Production Control Branch head of the shipyards collectively examined their inability to meet the NAVSEA requirements and jointly developed a solution to the problem. The best alternative was to obtain a current commercial "off-the-shelf", on-line, user friendly software package. Appropriate studies were performed to assess the actual requirements. The studies were transformed into a set of system specifications that described the objectives and potential benefits of FASS:

1. Objectives

* "To shorten ship availability durations by providing the capability to quickly asses remaining work and define appropriate management action.

* To increase the productivity of the Scheduling Section by eliminating manually prepared CPM (Critical Path Method) networks and bar charts.

* To have access to an automated, interactive project management system which can serve as a tool in evaluating the impact of proposed scheduling and workload forecast changes and their impact on one another.

* To have the capability to automatically "forecast resource problems" within a given schedule and identify the CPM activities involved which warrant immediate attention.

* To have the ability to input schedule adherence and progress data from remote locations.

* To establish a more meaningful relationship among project schedules, shop manpower resources, workload forecast, and progress data to aid in the analysis of performance and monitoring of schedule adherence.

* To maintain a Historical File for future availabilities."

2. Potential Benefits

* "To reduce overhaul durations and increase shipyard productivity.

* To improve the quality of schedules.

* To provide an automated interactive project management system which would serve as a tool in evaluating the impact of proposed scheduling and workload forecast changes and their impact on one another. This on-line modeling capability would allow shipyard management to review several alternatives of schedule changes and to select the best option in a timely manner.

* To provide an automatic forecast of resource problems within a given schedule and identification of the activities warranting immediate attention would allow shop managers to review manning problems far enough in advance to properly react/resolve manloading situations.

* An automated scheduling system would provide the ability to input schedule adherance and progress data from remote locations.

* To provide a more meaningful relationship amoung schedule, workload forecast and progress data would allow the analysis of cost and schedule performance.

* To provide for the existence of an automated historical file which would reduce scheduling effort by allowing similar work package schedules to be re-used with appropriate changes. This would also promote the sharing of work package schedules among shipyards reinforcing overhaul standardization and applying lessons learned throughout the shipyard community." [Ref. 7]

On February 1983, Philadelphia requested approval, via competitive procurement procedures, of an on-line scheduling system. In August 1983, NAVSEA PMS 309 and the Management Systems Support Division assumed responsibility for system acquisition for the Naval shipyards.

B. SYSTEM DESCRIPTION

The ARTEMIS software procured for the shipyards is a user friendly, on-line, real time management system package. The ARTEMIS will utilize a Hewlett Packard Mini 6000 series computer with various plotter, printer and graphic terminals. General characteristics of the overall system include a common, high level command language which is utilized throughout the system. This allows the first time user to be led through the various cycles and allows an advanced user to bypass initial instructions and proceed at their individual level. Self instruction facilities are maintained to help new personnel using the system. The established user may develop new data entry or retrieval formats and access data within the numerous data sets without affecting other users. The system is also capable of both on line or background processing. This capability allows the user to view the indicated process function and make corrections or changes as they are displayed.

A relational data base is utilized , with the ability of linking up to fifteen data sets using dynamically defined key fields. ARTEMIS can handle thirty two thousand activities per project, sixty four calenders, thirty two data sets and two hundred and fifty six resources per activity. The only limitation to handling

multiple projects is the storage capacity of the system. A standard shipyard package mix is shown in Figure 3. The software and hardware are standard in the package, with each shipyard having individual flexibility to purchase the appropriate peripherals as required.

As described in the Background Section, the thrust of the requirements of this system was to develop and maintain five levels of intergrated schedules. An overview of this process is graphically demonstrated in Figure 4 with a sampling of various inputs and output requirements.

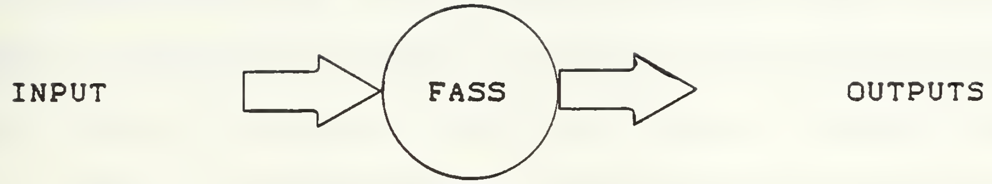
STANDARD SOFTWARE ITEMS

Scheduling System
Date Entry/Forms Management
Graphics
DBMS; utilities, query, report writer
Text Editor
Assembler
Cobol
Basic
Program DEBUG
Operating System
Utilities
Communications

STANDARD HARDWARE ITEMS

	Quanity
High Speed Printer Plotter	1
Printer Controller	1
High Speed 36 "; Plotter Controller	1
Electrostatic Plotter 36"; PLotter Controller	1
Multi-pen Table Top Plotter	1
KVDT with Printer Port	1
Micro Computer	4
KVDT Graphics	1
Printer/Plotter (200 cps)	2
KVDT Graphics High Resolution	1
Modems	6
Multiplexer	1

Figure 3 Standard Hardware/Software Package



<u>DATA</u>

manhour
key op data
start stop dates
material
cost

<u>PRODUCTS</u>

PERT/CPM schedules
management graphics
production reports

Figure 4 FASS Process

The data input problem can be accomplished by using tape transfer, a database or manual input. This specific area will be covered in depth in Chapter Four.

The approximate times involved in obtaining a product from the system can best be described with a view of two cases. The first case assumes a busy system with a very detailed PERT/CPM system of ten thousand activities. This

number of activities equate to a very detailed scheduling of a Destroyer class vessel. The time required to obtain the data from a data base, analyze it and have it ready to plot would be approximately one and a half hours. This allows the user to review the entire detailed overhaul PERT/CPM, which is not done on a routine basis due to the magnitude of data involved. The more practical case would be to review the overhaul of the destroyer at a four hundred activities level. The time required to obtain the data would be approximately two minutes with ten minutes required for the analysis portion. The information could then be viewed on a graphics terminal or plotted.

The second case involves an operation that will be executed on a more day-to-day basis. Supervisors utilizing a busy system with four hundred activities would normally desire to change information concerning approximately five specific jobs. The data call down time would be approximately two minutes, one minute for the data entry process and two minutes for analysis. In this mode FASS is providing much needed assistance in developing alternataive solutions through simulation. These two cases illustrate the quick response time that FASS will provide to the waterfront supervisors.

A system of this magnitude required each shipyard to conduct detailed on-site preparations to address the

question of housing the hardware and support systems. A typical hardware layout in the shipyard is illustrated in Figure 5. Each site also had to address requirements for primary and secondary electrical power, air conditioning and communications. The author's review of this planning aspect, indicated a thorough process had been undertaken which should provide an excellent support package for FASS.

C. INITIAL UTILIZATION CONCEPTS

Although the initial requirement for FASS was to comply with NAVSEA scheduling directives, shipyard management quickly grasped the magnitude of potential applications available from FASS. The ARTEMIS package also provided a desk top version for foreman and ship supervisors, which could link a limited number of terminals to the main system. With the combination of remote terminal sites and the desk top version, management saw the ability of providing real time information to the waterfront. The system also would provide the shipyard the ability to reassign job priorities, order the stop/start dates, and have ARTEMIS reconstruct the network to ascertain these effects on the critical path, resources and other events. This "what if" capability is an immense improvement over the existing manner of just estimating by the "seat of the pants" what the effect

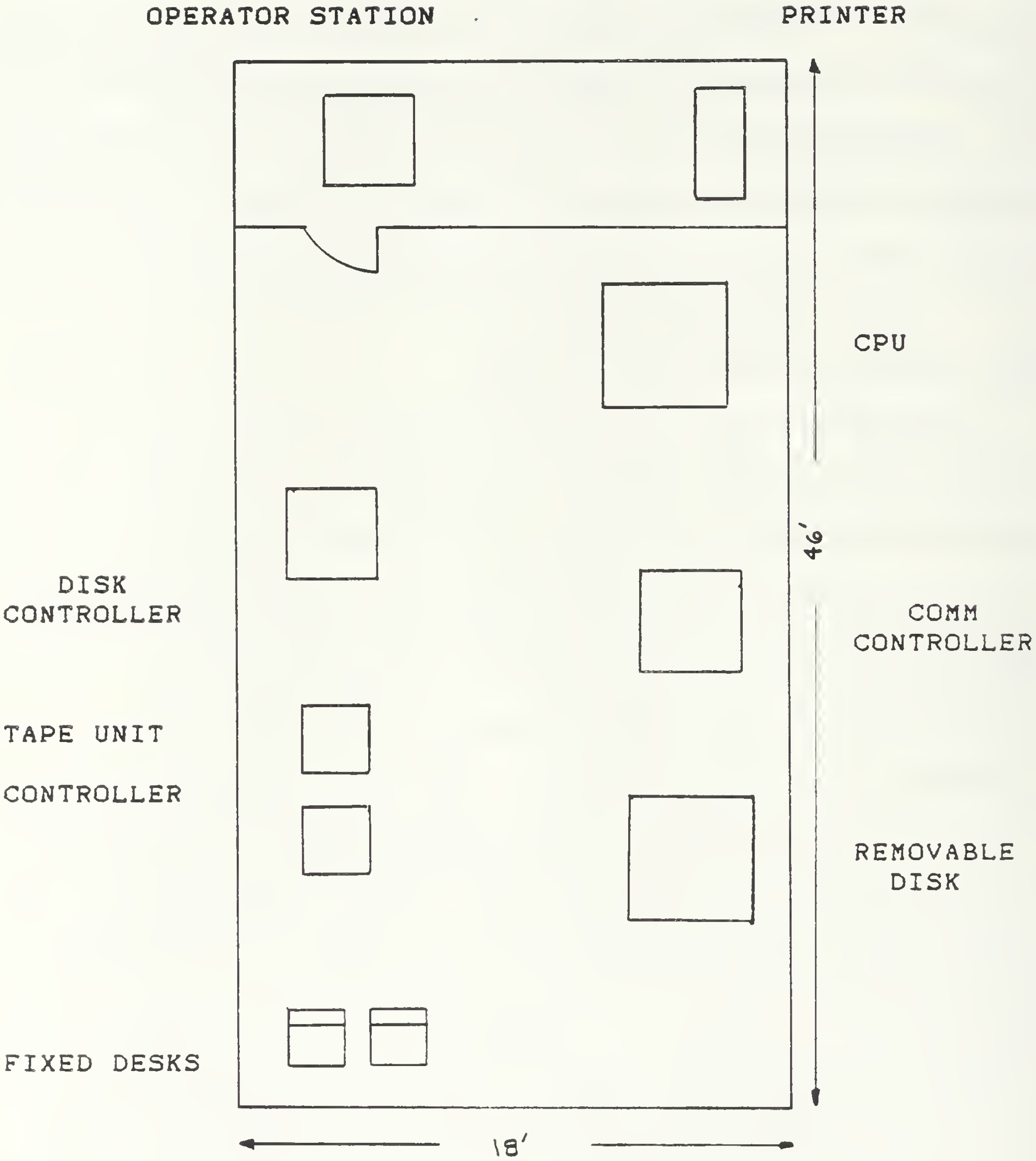


Figure 5 Typical Hardware Layout

would be. Several days of manual labor would be expended to develop new PERT/CPM schedules after major changes were proposed during the overhaul process. FASS's ability to provide this information within minutes is a quantum and welcomed jump in processing rates.

IV. IMPLEMENTATION PLANNING CONSIDERATIONS

A. INCORPORATING FASS INTO EXISTING SHIPYARD MIS

Shipyards face the same fundamental questions concerning system implementation that are present in private industry. After the initial issues of requirements, cost and benefits and system choice, the basic question arises of how to network, if at all, the procured system. The author considers this question crucial in that, improper integration of the system may reduce the overall effectiveness where as optimum integration provides a synergistic effect.

This basic question was assigned a high priority by shipyard management after the procurement phase began. The goal of the Scheduling Branch was to fully interface FASS with the existing shipyard MIS. The success of FASS hinged on the ability of obtaining real time information from the MIS. To better understand the magnitude of this problem, the basic shipyard MIS will be reviewed for the reader.

The shipyard MIS started its beginning during the early 1950's period as a package of high speed accounting applications and has evolved into a vital system that links the entire shipyard together. It's primary goal is to provide operational and predictive information to assist all levels of shipyard management and headquarters in the decision making procedure. Shipyard MIS is identical to

industry MIS in that the end goal is to provide accurate and timely information in a form that is meaningful to decision makers.

Organization of the shipyard MIS is shown in Figure 6, with the four major departments of the shipyard placed into functional subsystems. For each MIS subsystem the various subsystems application have been listed.[Ref.8]

At this point one can see that a large amount of information contained in the shipyard MIS is essential for scheduling a work package. Specifically FASS must obtain information concerning:

- workload forecasting
- availiable manhours for each trades
- data on materials and shop stores
- start/stop dates
- priority work in progress

The questions that immediately arise are: "How to obtain the required MIS information, what format is it in and does it require conversion?" Although these are basic questions, there are numerous answers and approaches to solve the problem.

DEPARTMENTS:	Planning/Production	Comtroller	Supply
MIS Subsystems:	Industrial	Financial	Material
Applications:	* Work Forecasting * Scheduling * Design	* Cost * Budget * Payroll	* Shop Stores * Materials * Accounts Payable

Figure 6. Shipyard MIS Organization

B. ESTABLISHED PLANS TO IMPLEMENT FASS WITHIN NAVAL SHIPYARDS

When the decision was made to procure FASS, each shipyard began to develop a strategy for implementing the system within their organization. Although, the method of allowing each shipyard to plan for its own implementation vice a structured Navy wide plan can be questioned as inefficient, the seperate shipyard research did allow the development of three seperate approaches, with each containing a unique solution. In order to examine the existing approaches, the author determined that the three shipyards plans warranted on-site investigation.

There are three basic strageties that will be examined for FASS implementation:

1. Use the system in a stand alone mode

2. Utilize a mainframe data base to interface with existing systems and FASS

3. Network FASS to the shipyard mainframe

Two of the three shipyards visited, plan to utilize the data base concept and one plans a mainframe connection. The stand alone strategy should be eliminated from consideration for shipyard use because of the severe limitations it places on the system. If this method is utilized data entry will consume significant amounts of personnel resources. Moreover, the aspect of limiting the entire shipyard to thirty two terminals or less is an unattractive constraint.

The following section will demonstrate how Puget Sound, Philadelphia and Long Beach, shipyards intend to implement FASS.

1. Philadelphia

Of all the shipyards visited by the author, the Philadelphia yard appeared to be the most concerned with the planning aspects of implementing FASS. Their basic concepts included organizational support, physical facilities, MIS interaction and system limitations.

Philadelphia identified the major FASS constraints as data entry, accessibility and memory. Although Philadelphia and Puget Sound identified the same problems, a different solution was developed by Philadelphia.

The Production Control Branch Head realized that the shipyard was quickly expanding their computer technology, which recently included the procurement of a PRIME 550 minicomputer. The addition of FASS and the expansion of personal computers required a long range unification and planning effort. The major areas which required a ground floor coordinated approach included:

* current capabilities
* long term capabilities
* effect of mini-micro computers
* net working
* organizational requirements

An extensive planning effort resulted in the concept of using a minicomputer to act as an interface with the existing shipyard computers. The minicomputer approach was designated as the Production Automated Support System.(PASS) The networking concept is depicted in Figure 7A. The main advantages will be:

* The ability to share data.
* The ability of to share hardware/software

* A capability of combining data files and standardizing formats.

* The optimum use of funds which allows less equipment and fewer phone lines.

PASS will eliminate the initial constraints by providing a database capability for all users. FASS will not require manual data entry, in that new information can be retrieved from PASS, utilized for scheduling and then dropped from FASS' memory. The PASS will also allow all existing shipyard terminals to obtain data from FASS.

After deciding on this approach, organizational changes were instituted. The responsibility for both PASS and FASS were assigned to the Performance Analysis, Control and Evaluation Section Head (PACE). This move placed all computers, less the main frame, under the control of one section. Appropriate actions were taken to obtain additional personnel to support the new responsibility. New personnel are required to:

* Provide systems analysis and design.

* Provide user training and guides.

* Provide trouble shooting, documentation responsibility and report development.

Procurement cost for the new minicomputer is estimated at seventy five thousand dollars, with delivery about six months after FASS is on board. The decision to adopt PASS

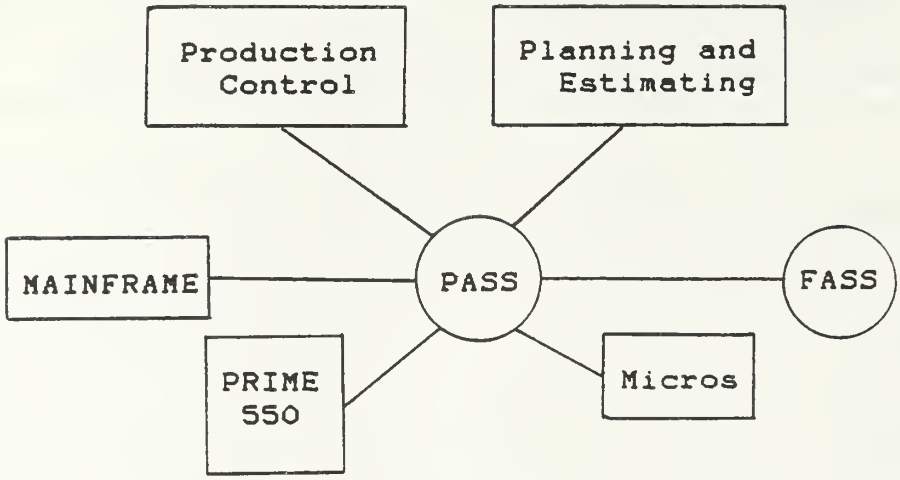


Figure 7A Philadelphia Networking

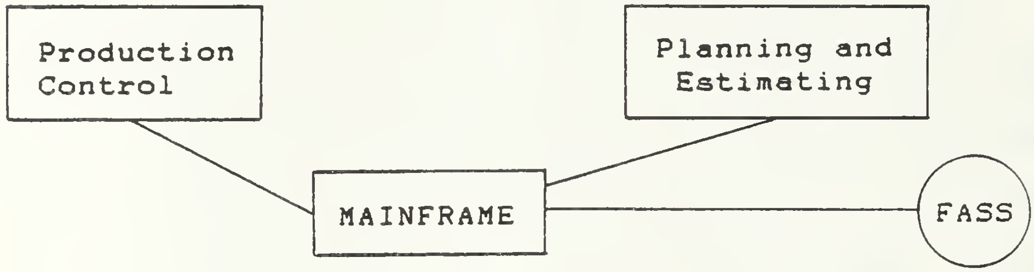


Figure 7B Long Beach Networking

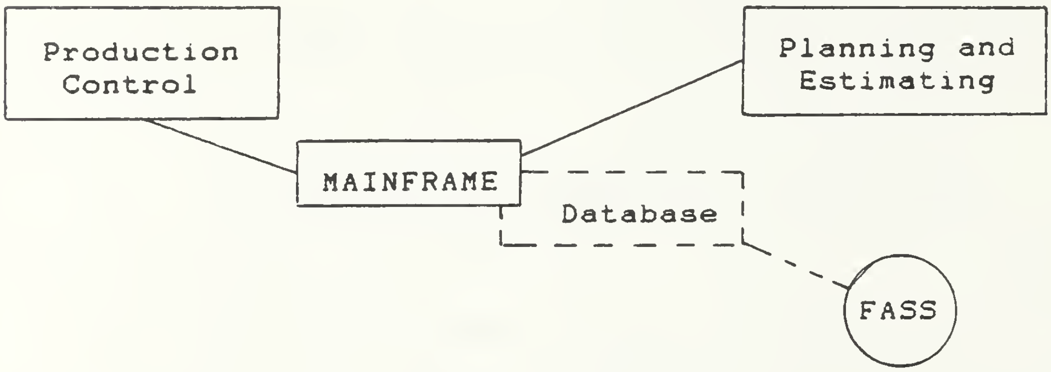


Figure 7C Puget Sound Networking

assumed the advantages of common networking and interface outweighed the additional cost of the mini computer and the additional procurement time. [Ref. 9]

2. Long Beach

On July 6, 1985, Long Beach Naval Shipyard completed their FASS acceptance test which was conducted by a team from outside shipyards and the Vendor. This was the first successful acceptance test. Puget Sound and Philadelphia tests would be conducted within a one month period.

The current plan is to connect FASS to the mainframe via a modem as shown in Figure 7B. This will allow FASS to retrieve as well as relay, information to the shipyard MIS. Information passed to MIS will include the start/stop job dates derived by FASS. FASS will retrieve from MIS, information developed by the planning and estimating department, to include material and manhour constraints.

This implementation plan is limited in that FASS requires a dedicated port into the mainframe in order to be fully interactive. Usage constraints currently negate the use of a dedicated port. This problem has a solution, specifically a larger mainframe, but is long term in nature. A more timely solution would be to review mainframe usage. Possible multiuser reductions or low priority user elimination could make a port available for FASS. This decision of course must be made at a high level

of management. When "what if" scenarios are conducted by supervisors and ship superintendents, they will always be dealing with information that is at least one day old. This is because the update of job work status will still be conducted in batch mode on the Production Control portion of MIS. To fully employ FASS capabilities, interaction is essential and a long term solution delays full implementation. [Ref. 10]

3. Puget Sound

In order to maximize the use of FASS, the Puget Sound Naval Shipyard clearly understood that early planning was the key to success. The time to establish an implementation plan was clearly not the day the equipment arrived.

Initially, management tried to establish what limitations and assets existed with FASS. They investigated potential major problems that could seriously jeopardize overall effectiveness of the system. The initial concern was that of over utilization and congestion of the system. If the shipyard was performing overhauls on a large number of vessels, the memory constraints would be critical if all relevant data was maintained within FASS. Interrelated with this problem was the limited number of terminals accessible to the user. The constraint of thirty two terminals for the entire shipyard posed a potential

problem area. Even more disconcerting was how to enter the required data, such as manhour input, material input and other resourse data [test equipment, components, documents, etc.] into FASS, and how would others obtain it.

In response, Puget Sound initially developed an approach that attempted to solve all the problem areas. The main thrust was to develop a Production Control Database on the shipyard mainframe that allowed interface with FASS, MIS and other mainframe applications. This system network is show in Figure 7c. The new Database provides a technique that frees FASS of storage and interface constraints. Data is retrived from the mainframe to answer the imposed querries. After the querry is answered the data is no longer required in FASS and may be deleted. Also by utilizing the database and mainframe, four hundred or more terminals become available. Additionally, this concept will allow the mainframe to continue processing the weekly reporting requirements and free FASS to handle limited distribution reports.

The potential problems discussesd above appear to be eliminated with the concept of the new database. Data entry by key punch or magnetic tape is eliminated becauses FASS will go direct to the mainframe for required data. Memory constraint is no longer a concern due to the

capability of deleting data after its use and terminal capacity was greatly increased. The database concept also addresses the previous concern of how current is the data in regards to actual in progress work. If a real time system is required but data is updated monthy, the effectiveness is minimum. The database allows personnel with the proper identity codes to update work status at any of the four hundred shipyard terminals. Of course a foreman or progressman will certainly not update all jobs daily, but the real time concept is there for the critical areas of concern to management. This now allows the shipyard to fully utilize a major asset of FASS, which is to conduct "what-if" plans in developing work strategties. The Repair Officer, Ship Supervisor and Foreman can put in various changes to the existing schedule and see the effects on the critical path and other events with assurance that the system has received all real time updates and is not waiting to be updated "tomorrow". FASS will also advise of possible problems in the areas of available man hours, materials and associated resources.

In summary, the advantages of Puget Sound's Database approach to FASS implementation are:

* It will allow for real time, on line updating capability.

* System updates to FASS data will be entered by both Foreman/Progressman and by the existing shipyard MIS.

* The increased terminals capacity will allow more personnel to utilize the results of FASS updates

* Real time work status will be utilized for "what-if" scenarios.

* The data base programs can be utilized by other Naval Shipyards due to common mainframe systems.

* The Naval shipyards near future procurement of new mainframes will not effect the use of the database and FASS. [Ref. 11]

C. OVERALL MANAGEMENT CONSIDERATIONS FOR THE USE OF FASS

1. Top Management Support

One of the most successful traps in acquiring any computerized system is the idea that the computer will come in and all by itself, eliminate the initial problem. However, throughout industry many companies are experiencing grave difficulties with the same computerized systems that their competition are successfully using. A recent study indicated that only ten percent of companies surveyed were getting the full use of their new computerized system. Thirty percent of the firms were getting good but not complete benefits and fifty percent were receiving little or no benefits from their system.[Ref. 12]

These results raise the question,"Will each Naval shipyard enjoy success from FASS or will the same percentages as above prove true?" Crucial problems in scheduling can be elminated by the use of FASS, however, the system cannot succeed without support. Regardless of

the size and complexity of any hardware/software package acquired, it will not fully function without the support and understanding of management. This committment goes much deeper than vocal support. First management must be educated on FASS and its capabilities. Involvement is essential in that the managers need to utilize the system and determine if the system meets their management needs. To fully utilize FASS, all levels of management may need to actually change the way they manage, plan and control many shipyard functions. The effective manager needs to determine:

* Does FASS provide information in a form that helps me manage?

* Is new information being provided? If so, how can I best use it?

* Is there other types of information that I need?

* Am I getting too much information from FASS?

* Do I really understand all the capabilities of the system?

* Is our organization structured to efficiently utilize the system? What changes would complement the system.

* Does my superior understand the system? Should more or less information be forwarded and in what form.

* Has FASS assisted me in my performance of duties? If not, can I effect changes in the system to support my needs without degrading overall effectiveness? What changes would help my people.

* Am I making my decisions with the data provided.

Questions of this nature are difficult, yet they are the crux of obtaining the full benefit from the system. The failure of shipyard managers to probe into these areas put the effectiveness of the Scheduling Branch in jeopardy.

2. Training and System Acceptance

Soon after arrival FASS will be operational, but will the system be fully utilized? The bottom line of any successful project is its use by the workers that make the company operate. Years of planning, decisions, specifications etc., will be virtually wasted if the system is not properly employed. Replacing the current FASS with a model that is four times costlier will not ensure that the system will be used. The majority of implementation problems do not involve software or hardware, they involve people, which make the shipyard run. [Ref. 13]

This author contends that the critical link in the application of FASS, will be the acceptance and use of the system by the first line supervisor and management. Upper Management can make people use the FASS, however they cannot make them accept it. Without their support and use, FASS will be severely undermined. But why shouldn't the supervisors use the system? They went to classes to

learn the system, now they just need to use it. This sounds simple from afar, yet management's biggest problem will be how to effect change of the individuals who use the system.

The view of management that FASS is a welcomed addition to shipyard management tool may not be shared by the line supervisors. A new system is often viewed as pure change, just a different mode of operation. This can evoke varied responses from each individual. Individual response may vary from excess uncertainty, fear about future competence and the fear of the system meaning more work. A new system not only means learning the details, but a change in the way day to day business is carried out. People in general resist change or the way the change is promulgated.

The challenge to management is to make the supervisors feel good about the change. Management must be able to obtain the agreement from the people that the new system is desirable and a benefit to all. There are numerous approaches to this problem. Listed below are a few ways to help bridge the change to a new system:

* Ensure that requirements and standards are clear.

* Encourage participation and suggestions on how to better use the system.

* Recognize successful supervisors and use them as models.

* Make the change in steps vice one giant leap.

* Allow proper time to digest the change before requiring a commitment.

* Establish a line supervisor user group to identify problems or concerns with the system. Employ this group to educate management on possible changes required to more effectively utilize the system.

* Provide training on how to make management decisions with information provided by FASS.

* Demonstrate management committment to the change. [Ref. 13:pp.13]

3. Post Review Program

After the first ships overhaul is converted to FASS and supervisors and management are fully utilizing the system, a post review program should be initiated. The time frame should be approximately 90 to 120 days after the start of a full one year overhaul. This review program is required to assess the effectiveness of the system. A formal methodolgy is essential in order to uncover possible flaws in FASS or the organizational support for the system. A review of this nature should reflect the findings of the informal supervisors users group recommended earlier. As a guide, the review should cover:

* Assesment of overall performance of the system. Is it an asset to the supervisors and management or a liability at this point?

* Review accessibility and its response time to queries.

* Information flow: Is too little information being received or to much? Is the information in a easily digestible form?

* Are there program changes to improve effectiveness?

* Has proper training been received concerning the use of FASS? Are there still areas that are confusing and not used?

* Has FASS changed the way upper management monitors and controls work in progress? Is this change assisting or burdening the supervisors.

* Is the Repair Officer and his Superintendents fully utilizing the system, or is it only being used by interested personnel? [Ref. 14]

This type of review will capture a large quantity of management's time. However, the alternative is to just wait and see how the overhaul proceeds and face the possibility of cost and duration overrun due to limitations or incorrect usage of the system which were not identified until top management had to step into the picture.

V. CONCLUSIONS

A. FASS USEFULNESS

After reviewing all the associated documentation (system specifications, requirement analysis and official correspondence) concerned with the acquisition of FASS, it was evident to the author that all personnel involved were dedicated to obtaining a quality product. The personnel resources devoted by the shipyards to the requirement and specifications phases of FASS was impressive. The approach of defining exactly what the user required and the needed system specifications, followed the textbook approach and was exceptional in quality.

The selected ARTEMIS system will have a positive impact on the shipyards scheduling process and overall effectiveness.

B. SYSTEM NETWORKING

A key concern of each shipyard, will be how to network FASS with existing systems. A system with the power of FASS cannot be fully utilized if used in a stand alone mode. The data requirements of FASS reside in the existing shipyard computer systems. To obtain maximum efficiency, required data must be passed via a network scheme, which will allow FASS to employ memory for

processing vice data storage, which could severly slow system response. Manual entry would negate the timeliness of FASS information.

C. SYSTEM ACCEPTANCE

Shipyard management has proven their ability to properly identify system requirements, procure and successfully install FASS. The technical talents are not wanting within the shipyard complex. FASS is ready to operate, but are the supervisors ready to accept FASS? Management's first real test will be their ability to make FASS "the accepted way" in the shipyard. Until this test is passed, FASS is preordained to become just another unused automated tool.

D. GROWTH

The diversity of FASS may actually create a usage problem after the system applications are fully comprehended and understood by management and supervisors. Many different and effective reports and graphs can be generated by both the main and desktop versions. After obtaining a working knowledge of the system, each manager may want to produce a management reporting package to suit his individual needs. This type of usage would not only duplicate information

requirements but would utilize processing time which was initially planned for other services.

VI. RECOMMENDATIONS

A. DATA ENTRY AND STORAGE

There are currently two basic methods to eliminate the data entry and storage concerns of FASS. Each shipyard must ascertain their own requirements and constraints, then decide which system is more effective. The first method is the approach taken by the Puget Sound Naval Shipyard. In developing a database for the mainframe, they solved both entry and storage constraints. By using in-house programming to develop the database, shipyard programmers can effectively make any desired changes and are not dependent upon outside contracting. The benefits of a shipyard employing this approach would be the ability to obtain the database package from Puget Sound, in that the mainframes are identical HONEYWELL H-6880. This implementation plan would be timely, minimize additional costs and solve the major implementation concerns of data entry and memory limitations.

The second implementation approach developed by Philadelphia Naval Shipyard also solves both major concerns mentioned above as well as expanding the

capabilities of the existing shipyard computer systems. Although this plan requires an additional procurement process the advantages gained are significant. The ability to link all computer systems, with the current and future mainframes, is essential in obtaining the optimum information exchange. Managers are allowed increased opportunity to access information via the PASS microcomputer networking. This increase in real time information is paramont in allowing management to control overhaul costs and duration. In adopting this approach, a shipyard would effect a basic modem/mainframe interface to start FASS and complete the networking when the minicomputer becomes availiable.

The benefits of both systems are summarized in Table I.

TABLE I

SUMMARY OF IMPLEMENTATION CRITERION

CRITERION	PHILADELPHIA	LONG BEACH	PUGET SOUND
Growth	Very good	Good	Good
Networking	Very good	Good	Very good
Data Entry	Good	Good	Good
Accessibility	Very good	Good	Very good

B. FASS CONTROL

A frequent problem with computer systems is the growth of company usage after the initial learning process is completed. An individual should be designated to oversee the usage of FASS. Success of a system often prompts individuals to employ it for additional applications. Although this will eventually increase overall productivity, it can lead to over taxing of the system if not properly reviewed, thereby slowing response time. The controlling manager should screen all individual new appliactions and determine the system's ability to undertake the new applications, and if possible, the manager combine management reports.

C. SUPERVISORS USER GROUP

In order to both increase supervisor acceptance and employment of FASS, a user group chaired by a supervisor, should be established. The goals of this group should be to better understand FASS capabilities through shared knowledge and to advise management of problem areas. This also serves as a vehicle to surface system usage problems that otherwise might not be voiced. This user group would also provide group peer discussions to help hesitant personnel better understand and thereby accept the system as "the management system".

D. IN HOUSE REVIEW

After the shipyards officially converts to FASS, a post review program should be scheduled. The purpose and timing is described in Chapter IV, Section D,3.

E. NAVSEA REVIEW

In that each shipyard has undertaken an individual implementation approach, the effectiveness of each plan should be evaluated by NAVSEA. The ability to review and observe the strengths and weaknesses of each plan could greatly benefit the naval shipyard complex. As previously discussed in Section D1 of Chapter 4, industry often has shown that one establishment can successfuly employ a computerized system, while its competitor fails to benefit from the same system. The commitment and resources allocated to FASS cannot be jeopardized due to ineffective implementation plans.

VII. FURTHER RESEARCH OPTIONS

Within six months the entire shipyard complex should be capable of using FASS as their main scheduling tool. The different inplementation approaches will surly produce varied results as how to best network and utilize FASS. This provides an excellent opportunity for research on how the shipyards views FASS and the lessons learned concerning implementation and use. A study of these lessons will identify actions that produced success which in turn will benefit all shipyards.

LIST OF REFERENCES

1. Director, Management Systems Support Division UNCLASS Letter 5230: Ser 148/705 to All Naval Shipyard Commanders, Subject:Status of Fundamental Automated Scheduling System (FASS) Procurement (U), 3 August 1984.

2. Secretary of the Navy, Notice 5450, 21 April 1956.

3. Commander, Philadelphia Naval Shipyard Instruction 5450.9, Shipyard Organization Manual, August 1983.

4. Management Systems Support Division, System Decision Paper to the Interim Automated Scheduling System, September 1983.

5. Commander, Puget Sound Naval Shipyard Instruction 4850.19, Event Management 29 November, 1984.

6. Naval Sea Systems Command Instruction 4850.0, Non Nuclear Scheduling Instruction, 28 February, 1984.

7. Management Systems Support Division, Fundamental Automated Scheduling System, System Specifications, July 1984.

8. Naval Ship Systems Command Computer Applications and Development Office,The Shipyard MIS: A Manual for Users, NAVSHIPS 0900-686010.

9. Interview between author and Zuber, D., Jones, D., Philadelphia Naval Shipyard, 4-8 March, 1985.

10. Interview between author and Anast, J., Long Beach Naval Shipyard, 3-6 June 1985.

11. Interview between author and Hansen, J., Puget Sound Naval Shipyard, 15-16 May 1985.

12. Anderson, J. C., Schroeder, R. G., "Getting Results From Your MRD System," Business Horizions, v27 n3, pp.51-64, May-June 1984.

13. Bloomer, T. L., "Do You Always Run a Gauntlet Trying to Effect Change?", Program Manager, V XIII, pp.10-13 November-December 1984.

14. McLeod, R., *Management Information Systems*, pp 620-623, Science Research Associates, Inc.

BIBLIOGRAPHY

Burch, J. G., Grudnikski, G. and Strater, F. R., INFORMATION SYSTEMS: THEORY AND PRACTICE, 2d ed., John Wiley and Sons, Inc., 1979.

Burton, K., "System integration Vital to Role of MIS Executives", COMPUTER WORLD, V 18, pp 32-25, 26 November 1984.

Chacko, G. K.,MANAGEMENT INFORMATION SYSTEMS, Petrocelli Books, Inc., 1969.

Dane, C. W., Gray, C. F., and Wookworth, B. M. "Factors Affecting the Successful Application of PERT/CPM Systems in a Government Organization", INTERFACES, V 9n5, November 1979.

Goldkuhl, G., Nilsson, A., and Lundberg, M., INFORMATION SYSTEMS DEVELOPMENT, Prentice-Hall., Inc. 1981.

Linder, J. C., "Avoiding Information Systems Failures", INFORMATION SYSTEMS, V 31, pp 98-100, October 1984.

Lucas, H. C., INFORMATION CONCEPTS FOR MANAGEMENT, McGraw-Hill Book Company, 1982.

Seddon, J. G. Concerting to a package; advice from the trenches on how to replace an aging production system with an off-the-shelf product". DATAMATION, V 29, October 1983.

INITIAL DISTRIBUTION LIST

		No. Copies
1.	Library, Code 0142 Naval Postgraduate School Monterey, California 93943-5100	2
2.	Mr. Mike Spencer, Code 54XQ Department of Administrative Sciences Naval Postgraduate School Monterey, California 93943-5100	2
3.	Mr. James D. Zuber, Jr. Philadelphia Naval Shipyard Code 375 Philadelphia, Pennsylvania 19112	15
4.	Mr. Jerry Hansen Puget Sound Naval Shipyard Code 379 Bremerton, Washington 98310	1
5.	Mr. Jim Anast Long Beach Naval Shipyard Code 379 Long Beach, California 90801	1
6.	Defense Technical Information Center Cameron Station Alexandria, Virginia 22304-6145	2
7.	Computer Technology Programs Code 37 Naval Postgraduate School Monterey, California 93943-5100	1